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ABSTRACT

The purpose of the two experiments was to assess the effects of two levels of stimulus redundancy and three levels of irrelevant visual stimulation on performance in a successive discrimination task and a reproduction task. The results indicate that increases in redundancy facilitated performance in the reproduction task but had no appreciable effect on performance in the successive discrimination task. Performance significantly decreased in both tasks as the amount of irrelevant stimulation increased. (KJ)

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CONCEPT FORMATION AND UTILIZATION IN THE PRESENCE OF IRRELEVANT VISUAL STIMULUATION

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Contents

	Page
Summary	1
Introduction	1
Method and Results	2
Experiment 1	2
Subjects	2
Patterns	3
Task and Procedure	3
Results	3
Experiment 2	3
Subjects	3
Task and Procedure	3
Results	3
Conclusions and Recommendations	4
Conclusions	4
Recommendations	4
References	5

Summary

Two experiments assessed the effects of 2 levels of stimulus redundancy and 3 levels of irrelevant visual stimulation on performance in a successive discrimination task and a reproduction task. The results indicated that increases in redundancy facilitated performance in the reproduction task but had no appreciable effect of performance in the successive discrimination task. Performance significantly decreased in both tasks as the amount of irrelevant stimulation increased. These findings are discussed in terms of the different strategies which appeared to underlie performance in the two tasks.

Introduction

A number of studies (e.g., Edmonds & Mueller, 1967a, 1967b; Edmonds, Mueller, & Evans, 1966) have utilized patterns generated by a computer program VARGUS 7 (Evans, 1967), to study schematic concept formation in several perceptual tasks. The schema in these patterns is composed of particular column height sequences favored by the transitional probabilities of a seven element Markov process. Constraint redundancy is determined by the magnitude of the probabilities associated with the schematic sequences and so can be manipulated independently of the schema. The schema itself can be independently manipulated by varying the favored or most probable column height sequence. In fact, a population of schemata (column height sequences) can be defined and sampled. In addition, the pattern generation procedure allows construction of nonsense forms to have schemata which have been provided neither by experience nor by heredity.

In a series of experiments designed to investigate mixed schema learning, Edmonds & Mueller (1967a) found that in a modified oddity task Ss readily learned to distinguish among several schemata without knowledge of results. Edmonds & Evans (1966a) and Edmonds & Mueller (1967b) further demonstrated that in both a single schema and a mixed schema reproduction task learning not only occured in a rather spontaneous manner, but could be predicted quite accurately with new Ss and with patterns randomly selected from a different population (schema).

The schema recognition process evidenced in these studies appears to be identical to concept recognition or to the recognition of equivalence classes. The extreme effectiveness of schema learning is demonstrated by the ability of Ss to assign instances to their appropriate schema family without any external source of information. This formation of equivalence classes reduces the amount of information that must be processed since all members of one class can be encoded with the same schema. For example, once a schema representing human faces is learned, a particular human face may be recognized by processing only the information in that face that deviates from the "human face" schema.

One problem, however, which has received relatively little attention, concerns the effects of visual noise on the recognition of

redundant stimuli. Although a number of investigators (e.g., Attneave & Arnoult, 1956; Posner, 1964) have studied the properties of distorted forms, the experiments conducted by Rappaport (1957) are especially pertinent to this problem. He investigated the effects of two types and four levels (amounts) of redundancy on the ease with which forms perturbed by noise are recognized. When background noise was present, redundancy facilitated rapid recognition. However, when background noise was absent, an increase in redundancy was accompanied by slower recognition. There were no significant differences between the two types of redundancy in the noise-free situation.

Rappaport attributed the lack of differences between the two types of redundancy in the simultaneous recognition test to the nonutilization of redundant features of a stimulus by S when external noise was present. He believed that the longer sorting times in the noise-free situation were due to the difficulty of discriminating the smaller details in the figures which were more redundant. Edmonds, Walker & Evans -(1969) found that in the noise-free situation redundancy facilitated performance in tasks (reproduction) imposing memory requirements but was detrimental to performance in a successive discrimination task. These results, in conjunction with Rappaport's findings, thus indicate that Ss do not appear to use redundant cues in either a simultaneous recognition task or a successive discrimination task but only in tasks involving substantial memory requirements.

The present study, using quantified stimuli and an improved method for producing visual noise, was designed to assess more precisely the effects of different levels of noise and redundancy on schematic concept utilization in the successive discrimination task (Experiment 1) and the reproduction task (Experiment 2). A fact that should be emphasized is that an increase in redundancy produces an increase in the probability of a certain column height sequence (schema). Consequently, an increase in redundancy at a particular noise level should benefit performance since S would be progressively better able to learn and utilize the schema. This supposition particularly holds for the reproduction task where the use of a schema permits a considerable reduction in the amount of information that must be stored to remember a pattern. The successive discrimination task imposes a less severe memory requirement than does the reproduction task because a particular pattern does not have to be completely remembered to be selected correctly from among similar patterns. In fact, as noted above, performance in this type of perceptual task may be rather independent of level of redundancy since Ss may need only to utilize the non-redundant aspects of the stimuli for successful differentiation.

Method and Results

Experiment 1:

Subjects. The Ss were 60 undergraduate students enrolled in psychology courses at Augusta College. They were randomly assigned to the six treatment combinations.

Patterns: VARGUS 7 was used to generate 12 column 33% and 67% re-

dundant patterns containing the same schema. These patterns served as input to another computer program, VARGUS 6, which accepts patterns in black and white and transmits them to output patterns with any desired level of noise. In this context, noise means that every cell is transmitted with a specified probability of being changed to its opposite state. In VARGUS 6, the probability of error is the same for all cells. The probability levels for correct transmission were .75, .85, and 1.00. For the 1.00 probability (no noise), VARGUS 6 and VARGUS 7 patterns were identical.

Task and Procedure. Each S was given a 30 page booklet representing the appropriate noise level. Each odd page of the booklet contained a different VARGUS 7 patterns. Each even page of the booklet contained the VARGUS 6 test pattern corresponding to the preceding VARGUS 7 pattern along with two similar VARGUS 6 patterns (confusion patterns). The Ss were allowed 15 sec. to view each VARGUS 7 pattern. They were then given 30 sec. to turn to the next page of the booklet and select the distorted test pattern from among the three patterns. The position of the test pattern was randomly determined for each page. No knowledge of results were given.

Results. Using number of patterns identified correctly as the responses variable, a two-way analysis of variance, Redundancy (33%, 67%) X Noise (1.00, .85, .75), indicated that the Noise main effect was significant, $F(1,24) = 3.28$, $p < .05$. The Redundancy main effect and the interaction were not significant. The results of the Tukey (a) procedure, which was used to test the differences between the means of the three noise levels, showed that as noise increased performance significantly decreased.

Experiment 2:

Subjects. The S were 60 undergraduates (different from Experiment 1) enrolled in psychology courses at Augusta College.

Task and Procedure. The patterns used in Experiment 1 were also used in this experiment. Each S reproduced 15 patterns in the appropriate condition. A Kodak projector exposed each of the VARGUS 6 patterns, mounted on a 2 X 2 in. slide, onto a white screen for 25 sec. After each exposure, S turned to a sheet in a mimeographed booklet where the corresponding VARGUS 7 pattern was printed with three columns omitted. The Ss were given 45 sec. to draw the three omitted columns in each pattern. The inter-trial interval was 15 sec. Since the nature of this task precluded schema learning, Ss received reproduction pretraining to acquaint them with the schematic or redundant aspects of the stimuli. In pretraining, Ss were given 15 reproduction trials with patterns of the same level of redundancy as they were to encounter in the experimental task.

Results. An analysis of variance based on the number of pattern columns reproduced correctly in the testing phase indicated that the Redundancy and Noise main effect were significant ($p < .01$). The Redundancy X Noise interaction was not significant. An individual comparison showed that the 67% redundant patterns were reproduced sig-

nificantly ($p < .01$) better than the 33% redundant patterns. Comparisons among noise levels indicated that as noise increased performance significantly decreased ($p < .05$ for all comparisons).

Conclusions and Recommendations

Conclusions

The results may be summarized as follows:

1. Increases in the levels of redundancy used in the present study facilitate performance in the reproduction task but have no appreciable effect on performance in the successive recognition task.
2. Performance significantly decreases in both the discrimination and reproduction tasks as noise increases at each redundancy level.

The results of these experiments suggest that different strategies underlie performance in the two tasks. In the reproduction task, where S is required to store all of the information contained in the pattern, schematic or redundancy encoding allows a considerable reduction in the information necessary to effect reproduction since only those elements which deviate from the schema need be remembered. Consequently, as the patterns become more redundant, less information must be processed in order to perform the task successfully.

Increases in redundancy do not appreciably affect discrimination performance since S can simply use the distinctive aspects of the stimuli for discrimination. It should be pointed out, however, that substantial increases in redundancy would produce sets of patterns that are highly similar and more difficult to discriminate than patterns possessing low redundancy. Moreover, patterns which contain no similar attributes (0% redundant) should be discriminated better than redundant patterns which are relatively similar (see Edmonds, Walker & Evans 1969).

The results indicate that visual noise affects discrimination and reproduction performance quite similarly. Increasing the amount of irrelevant stimulation reduces the capability of S to utilize the distinctive aspects of the stimuli, which are the features necessary for successful performance in both of the tasks (assuming redundancy encoding has occured in the memory task).

Recommendations

These experiments provide information concerning the strategies humans appear to use in two perceptual tasks and indicate the detrimental effects of stimulus distortion on these strategies. Further research should seek to specify more systematically the relationship between amounts and/or types of visual noise on performance in a variety of tasks imposing differential memory requirements.

Schema theory appears to be relevant to numerous educational processes. For example, measurement of the ability of children to learn schematic concepts offers the possibility of a non-verbal device to evaluate the intellectual and developmental stages. In addition, more

complete information concerning the conditions that facilitate and retard schematic concept formation may provide improved methods for teaching children and computers to recognize letters, hematologists to recognize malignant blood cells, etc. Research is currently being formulated to investigate the relevance of schema theory to these and other processes.

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